Radiosurgery Treatment Planning Optimization via Mixed Integer Programming

An expert system has been developed which automatically generates optimized LINAC radiosurgery treatment plans using a mixed-integer programming (MIP) engine in a fraction of the time typically needed in planning. The physician prescribes dose constraints for both normal tissue structures and tumor volumes. An objective function such as minimizing the dose to normal tissue or maximizing dose to the tumor volume may be selected. The expert system is then capable of automatically (i.e. no human intervention) generating a treatment plan, including the determination of the number and location of isocenters, beam orientation, beam size and beam intensity. The expert system also allows the planner to impose constraints on physical planning parameters such as the maximum number of target points and maximum number of arcs to ensure that the optimal plan will be sufficiently easy to implement in clinical practice. This study evaluates the resulting treatment plans from our expert system versus human expert planners. Two patient cases are presented in this study: 1) tumor volume adjacent to a critical structure and 2) critical structure embedded in a normal tissue structure. Spatial dose evaluation, dose-volume histograms and figures of merit are used to analyze the computer-generated and manual plans. These initial patient cases indicate that the expert system has an excellent potential of becoming an effective component for conventional radiosurgery treatment planning and delivery.